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Optimizing Liver Retraction in Laparoscopic Sleeve Gastrectomy: A Comparative Study of Three-Stitch Suspension Versus Nathanson Retractor

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Abstract

Introduction/Purpose

Optimal liver retraction is crucial during laparoscopic sleeve gastrectomy (LSG), especially in patients with hepatomegaly or steatotic liver. Traditional rigid retractors like the Nathanson liver retractor (NLR) provide stable elevation but require an extra trocar, which can contribute to instrument crowding and increased port-site trauma. The Three-Stitched Suspension is a minimally invasive, trocar-sparing alternative designed to distribute tension evenly across sutures, thereby optimizing ergonomics and potentially improving cosmetic outcomes.

Materials and Methods

This retrospective study evaluated patients who underwent LSG at Rajavithi Hospital, Thailand, between January 2020 and July 2025. Patients were assigned to either the Three-Stitched Suspension or NLR group. The primary outcome was operative exposure (operative view score). Secondary outcomes included operative time, trocar count, liver adjustments, blood loss, hospital stay, and liver-related complications.

Results

Of 145 analyzed patients (Three-Stitched = 71; NLR = 74), baseline characteristics were comparable. The median operative view score was 5 in both groups, with > 97% achieving ≥ 4 ($p = 0.555$). Operative time, suspension time, blood loss, and hospital stay were similar. The Three-Stitched group required significantly fewer trocars (median 3 vs. 4, $p < 0.001$). No liver injury, mortality, or reoperation occurred. Two Three-Stitched patients (2.82%) required conversion to NLR.

Conclusion

The Three-Stitched Suspension technique provides comparable operative exposure and safety to the NLR, while significantly reducing trocar requirements. It represents a safe, less invasive alternative for liver retraction during LSG, potentially benefiting reduced-port metabolic bariatric surgery (MBS).

Introduction

Obesity has become increasingly prevalent worldwide and has escalated into a global epidemic, with a higher incidence among women than men(1). Metabolic bariatric surgery (MBS) is one of the most effective treatment modalities for obesity, leading not only to sustained weight reduction but also to significant improvement or resolution of obesity-related associated medical problems such as diabetes mellitus, hypertension, dyslipidemia, non-alcoholic fatty liver disease (NAFLD), non-alcoholic steatohepatitis (NASH), obstructive sleep apnea (OSA), and coronary artery disease (CAD) (2, 3).

Among MBS procedures, laparoscopic sleeve gastrectomy (LSG) has gained worldwide acceptance due to its relative technical simplicity, safety, and favorable metabolic and weight-loss outcomes. Adequate exposure of the esophageal hiatus during LSG is essential for safe gastric dissection and minimizing complications. Effective liver retraction is therefore a critical step, especially in patients with obesity who often present with an enlarged left hepatic lobe due to NAFLD (4).

The conventional method for liver retraction involves the use of the Nathanson liver retractor (NLR), which requires placement through an additional subxiphoid incision. While this technique provides stable exposure of the esophageal hiatus, it is associated with certain drawbacks, including instrument crowding, compromised surgical ergonomics, and increased port-site trauma from the additional abdominal incision (5).

To address these limitations, alternative suture- or suspension-based techniques have been developed to retract the liver without requiring an additional subxiphoid incision. However, many existing methods, such as a single crural stitch or simple V-shaped suspensions, may suffer from liver slippage or elastic recoil during prolonged operations.

Building on these concepts, we developed the Three-Stitched Suspension technique, which utilizes 2 – 0 multifilament sutures at three distinct anchoring points: (1) the anterior abdominal wall, (2) the superior edge of the right crus, and (3) the falciform ligament. This specific triangulation provides a unique biomechanical advantage; by distributing the retraction vectors across three distinct anatomical axes, the technique prevents liver slippage, minimizes elastic recoil, and maintains a highly stable operative field without the need for an additional mechanical retractor. At our institution, approximately 60 LSG procedures are performed annually, and since 2020, the Three-Stitched Suspension technique has been adopted as an alternative method for intraoperative liver retraction. Therefore, the present study was conducted to evaluate the success rate of liver retraction and the incidence of procedure-related complications using this technique compared with the Nathanson liver retractor in patients undergoing LSG.

Materials and Methods

Study Design and Population

This retrospective study was conducted at Rajavithi Hospital, Thailand, and included all patients who underwent LSG between January 2020 and July 2025. The study was approved by the local Research Ethics Committee (Approval No. 68185). All procedures were performed by three senior bariatric surgeons with more than five years of experience. Patients were divided into two groups according to the method of liver retraction: the three-stitched suspension technique group and the Nathanson liver retractor group.

The primary objective was to evaluate the efficacy of liver elevation using the three-stitched suspension technique compared with the Nathanson liver retractor using operative view scoring (Table 1). The

secondary objective was to assess complications associated with liver elevation in both techniques.

In this study, the sample size was calculated using the formula for comparing the means of two independent groups(6). The calculation was based on a previous study(7), which reported a mean operative view score of 4.3 ± 0.7 in the K-wire retractor group and 3.9 ± 0.9 in the suture-based retractor group. Based on these parameters, a total sample size of 64 patients was required. Allowing for an additional 6 patients to account for potential dropout, the final planned sample size for this study was 70 patients per group, resulting in a total of 140 patients.

Table 1: Operative view scoring

	Operative view scoring
5 (best)	Good working space and ability to view GEJ, angle of His, LC, and GC
4	Adequate working space and ability to view GEJ, angle of His, LC, and GC
3	Adequate working space and ability to view any 3 among GEJ, angle of His, LC, and GC
2	Adequate working space and ability to view any 2 among GEJ, angle of His, LC, and GC
1 (worst)	Poor view

GEJ gastroesophageal junction, *LC* lesser curvature of the stomach, *GC* greater curvature of stomach

Study Groups

The three-stitched suspension technique was routinely adopted at our institution beginning in January 2020. Inclusion criteria were: age 18–65 years, diagnosis of severe obesity, complete clinical data, and signed informed consent. The indications for LSG followed standard Asian criteria: a body mass index (BMI) ≥32.5 kg/m² with at least one obesity-related comorbidity, or a BMI ≥37.5 kg/m² without comorbidities.

Exclusion criteria were: incomplete data, patients undergoing bariatric procedures other than LSG, cases in which liver retraction was not performed, patients with liver cirrhosis, and those with hiatal hernia diagnosed preoperatively by esophagogastroduodenoscopy (EGD).

Surgical Techniques

Three-stitched suspension technique

After induction of general anesthesia and endotracheal intubation, patients were placed in the supine position. The camera port was inserted 15 cm below the xiphoid process and slightly left of the midline. After pneumoperitoneum establishment and trocar placement, a multifilament suture was introduced.

- The first stitch was placed at the anterior abdominal wall over the midpoint of the left hepatic lobe.

- The second stitch was applied to the superior edge of the left crus, just above the hiatal opening. A 5-cm piece of cigarette gauze was placed beneath this stitch to prevent liver injury.

- The third stitch was placed at the falciform ligament below the inferior hepatic margin.
- The suture was exteriorized through a trocar positioned beneath the right costal cartilage or the left working port. Gentle traction was then applied and secured with a clamp to provide adequate exposure of the hiatus.

Nathanson liver retractor technique

In the Nathanson group, an additional 5-mm trocar was introduced in the subxiphoid area, and the Nathanson liver retractor was positioned to elevate the left lobe of the liver.

Data Collection

Data were retrospectively obtained from electronic medical records and intraoperative video recordings. To rigorously mitigate subjective bias in evaluating the primary outcome, the intraoperative videos were processed by an independent research assistant. The assistant created standardized, short video clips and removed all patient identifiers and specific instrument handling that could reveal the surgeon's identity or the surgical approach. Furthermore, the operative view score was specifically evaluated during the most critical step of the procedure: the dissection of the angle of His and the complete exposure of the left crus. These blinded, standardized clips were then independently reviewed by three experienced bariatric surgeons. Each surgeon graded the exposure using the 1-5 operative view scoring system. The final operative view score for each case was subsequently determined through a consensus meeting among all three surgeons, where individual evaluations were discussed and weighted to reach a final agreement. Other collected variables included demographic data, BMI, prior abdominal operations, time required for retractor placement, total operative time, frequency of intraoperative liver retractor adjustments, and liver-related complications.

Statistical Analysis

Continuous variables were analyzed using the Student’s t-test or Mann–Whitney U test, as appropriate. Categorical variables were compared using Fisher’s exact test or the chi-square test. Descriptive statistics were used to summarize the data. One-way ANOVA was employed to compare normally distributed quantitative variables between groups. Statistical analysis was performed using SPSS version 22.0. A p-value <0.05 was considered statistically significant.

Results

Demographic characteristics (Table 2) of patients Between January 2020 and July 2025, a total of 188 patients were admitted to our institution for LSG. Of these, 145 patients met the inclusion criteria. In this study, 71 patients underwent laparoscopic gastrectomy with the Three-Stitched Suspension method, and

74 with the Nathanson Retractor method. The cohort included 24 males and 121 females, with a median age of 33 years (range: 22–66 years) and a median BMI of 42.42 kg/m² (range: 31.18–79.40 kg/m²). There were no significant differences between the two groups in sex, age, associated medical problems, weight, height, BMI, and baseline liver function test.

Operative Outcomes (Table 3) The median operative time was identical between groups (76 minutes; range 60–120; p = 0.85). The median time required for liver suspension was similar (2 minutes vs. 3 minutes, p = 0.6035). However, the median number of trocars used was significantly lower in the Three-Stitched Suspension group (median 3 vs. 4, p < 0.0001), demonstrating a reduction in port usage with the suture-based technique. Method conversion to another technique occurred in two cases (2.82%) in the Three-Stitched Suspension group and none in the Nathanson group (p = 0.146).

Operative View and Safety Outcomes (Table 4) The median operative view score was 5 in both groups, with no significant difference when assessed as a continuous variable (p = 0.8703) or as categorical grades (p = 0.555). More than 97% of patients in both groups achieved an operative view score of 4 or 5. There were no cases of liver injury, liver laceration, mortality, or reoperation in either group. Median intraoperative blood loss was 10 mL (range 10–25) and did not differ significantly between the three-stitch and Nathanson groups (p = 0.8241).

Table 2
Baseline Characteristics

Characteristics	Total (n = 145)	Three stitch (n = 71)	Nathanson (n = 74)	P-value
Sex, n (%)				0.434
Male	24 (16.55)	10 (14.08)	14 (18.92)	
Female	121 (83.45)	61 (85.92)	60 (81.08)	
Median age, median years (range)	33 (22–66)	35 (23–66)	32 (22–57)	0.2008
Comorbidity, n(%)	144 (99.31)	71 (100.00)	73 (98.65)	0.326
Diabetes mellitus	43 (29.66)	20 (28.17)	23 (31.08)	0.701
Hypertension	63 (43.45)	35 (49.30)	28 (37.84)	0.164
Dyslipidemia	42 (28.97)	21 (29.58)	21 (28.38)	0.874
NAFLD/NASH	47 (32.41)	25 (35.21)	22 (29.73)	0.481
Obstructive sleep apnea	134 (92.41)	68 (95.77)	66 (89.19)	0.134
CVD	1 (0.69)	1 (1.41)	0 (0)	0.306
PCOS	34 (23.45)	18 (25.35)	16 (21.62)	0.596
OA	4 (2.76)	3 (4.23)	1 (1.35)	0.291
TIA/CVA	1 (0.69)	1 (1.41)	0 (0)	0.306
CVI	3 (2.07)	0 (0)	3 (4.05)	0.086
CHF	0 (0)	0 (0)	0 (0)	-
Gout	1 (0.69)	1 (1.41)	0 (0)	0.306
Median height, cm (range)	164 (143–188)	161 (144–188)	168 (143–185)	0.5033
Median weight, kg (range)	119.3 (76.00-265.70)	114.8 (79.00-223.50)	120.9 (76.00-265.70)	0.6736
Median BMI, kg/m^2 (range)	44.42 (31.18–79.40)	46.44 (32.07–66.01)	43.21 (31.18–79.40)	0.1806

Table 3
Operative Outcomes

Median length of hospital stay, hour (range)	**108 (96–120)**	**108 (96–120)**	**106.5 (96–120)**	**0.5121**
Median length of operation, minutes (range)	76 (60–120)	74 (61–120)	77.5 (60–116)	0.8508
Median time taken for liver suspension, minute (range)	3 (2–5)	2 (2–5)	3 (2–4)	0.6035
Median number of trocars	4 (3–6)	3 (3–5)	4 (4–6)	**< 0.001**
Liver adjustment, times (range)	0 (0–5)	0 (0–2)	1 (0–5)	0.6886
Method change to another technique	2 (1.38)	2 (2.82)	0 (0)	0.146

Table 4
Operative View and Safety Outcomes

Operative view score (continuous), median (range)	**5 (3–5)**	**5 (3–5)**	**5 (4–5)**	**0.8703**
Operative view score (categorical), n (%)				0.555
1	0 (0)	0 (0)	0 (0)	
2	0 (0)	0 (0)	0 (0)	
3	1 (0.69)	1 (1.41)	0 (0)	
4	39 (26.90)	18 (25.35)	21 (28.38)	
5	105 (72.41)	52 (73.24)	53 (71.62)	
Liver injury, n (%)	0	0	0	-
Laceration	0	0	0	-
Mortality, n (%)	0 (0)	0 (0)	0 (0)	-
Reoperation, n (%)	0 (0)	0 (0)	0 (0)	-
Median blood loss, ml (range)	10 (10–25)	10 (10–20)	10 (10–25)	0.8241

Discussion

Adequate exposure of the esophagogastric junction is a critical determinant of safety and efficiency during LSG, particularly in patients with severe obesity and NAFLD. Traditionally, the Nathanson liver retractor (NLR) has been widely used to achieve stable liver elevation; however, its use has been associated with additional incisions, instrument crowding, and increased port-site trauma (5, 7, 8).

In the present study, the Three-Stitched Suspension technique demonstrated comparable operative exposure and safety compared with the Nathanson retractor, while significantly reducing the number of trocars required. Both techniques achieved excellent operative view scores, with more than 97% of cases in each group attaining a score of 4 or 5, indicating adequate visualization of the hiatus.

Our results are consistent with previous reports describing suture-based or suspension-type liver retraction techniques. Crural stitch and liver suspension methods have been shown to provide satisfactory exposure with minimal liver trauma and without the need for additional subxiphoid ports (9–12). Huang et al. described the V-shaped liver suspension technique using a Penrose drain, reporting reliable exposure and no liver-related complications, even in bariatric patients with enlarged fatty livers(13). Similarly, needle-based or trocar-free techniques have demonstrated shorter retraction times and reduced interference with operative instruments(10).

The Three-Stitched Suspension technique offers significant practical and ergonomic advantages. By eliminating the need for a subxiphoid trocar, this approach reduces port-related trauma, minimizes instrument clashing in the upper abdomen, and may improve cosmetic outcomes. The reduced number of trocars observed in this study aligns with the principles of minimally invasive surgery and parallels trends toward needlescopic and trocar-sparing techniques reported in the literature(9, 13). Furthermore, because the technique relies on standard sutures and gauze rather than specialized mechanical devices, it may serve as a potentially cost-effective alternative in resource-limited settings, though formal health economic evaluations are required to confirm this hypothesis.

In the present study, the number of intraoperative liver adjustments tended to be lower in the Three-Stitched Suspension group compared with the Nathanson liver retractor group (median 0 vs. 1). This mechanical stability is directly attributed to the biomechanical advantage of the technique's specific triangulation. Unlike standard single-stitch or V-shaped suspensions, anchoring the liver at the anterior abdominal wall, the left crus, and the falciform ligament distributes retraction forces across multiple distinct vectors. The inherent stiffness of multifilament sutures (13, 14), combined with this triangulated configuration, helps maintain sustained traction and effectively prevents elastic recoil or liver displacement once optimal tension is achieved (13). In contrast, rigid mechanical retractors such as the Nathanson retractor exert focal pressure on the liver parenchyma and may require intermittent readjustment due to liver deformation or interference with operative instruments (5, 7, 8). Minimizing this adjustment frequency limits liver manipulation and maintains stable exposure, making the Three-Stitched technique a viable and clinically relevant option during LSG, particularly for patients presenting with NAFLD or NASH (15).

Despite these advantages, two cases in the Three-Stitched group required conversion to an alternative liver retraction method. Both patients had a body mass index of 54 and 60 kg/m², respectively, and exhibited severe fatty liver. These factors likely contributed to the need for conversion from the Three-Stitched Suspension technique to the Nathanson liver retractor. This highlights that suture-based techniques may be technically demanding in selected patients, such as those with extreme

hepatomegaly or dense adhesions. Nonetheless, the low conversion rate and absence of adverse outcomes indicate that the technique remains safe and feasible when performed by experienced bariatric surgeons.

Limitations

This study has several limitations that should be acknowledged. First, its retrospective design introduces the possibility of selection bias and unmeasured confounding factors. Second, the primary outcome relied on a 1–5 operative view scoring system, which is inherently subjective. Although we rigorously attempted to mitigate surgeon bias by utilizing a blinded video review process and requiring a consensus score among three bariatric surgeons, some degree of subjectivity may inherently remain. Third, all procedures were performed at a single tertiary center by experienced bariatric surgeons; the reproducibility of the Three-Stitched Suspension technique in lower-volume centers or among less experienced surgeons remains to be determined. Finally, long-term outcomes, including postoperative pain, cosmetic satisfaction, and port-site complications, were not assessed.

Conclusion

The Three-Stitched Suspension technique provides safe, effective, and reproducible liver retraction during laparoscopic sleeve gastrectomy, achieving operative exposure comparable to the Nathanson liver retractor. This suture-based approach significantly reduces the number of trocars required and avoids the need for an additional subxiphoid incision, without increasing operative time, blood loss, or perioperative complications. The technique represents a minimally invasive alternative for liver retraction in MBS and is a viable option for patients with NAFLD. Further prospective randomized studies are warranted to confirm these findings and to evaluate long-term clinical outcomes.

Abbreviations

BMI
Body mass index
EGD
Esophagogastroduodenoscopy
LSG
Laparoscopic sleeve gastrectomy
MBS
Metabolic bariatric surgery
NAFLD
Non-alcoholic fatty liver disease
NASH
Non-alcoholic steatohepatitis
NLR

Nathanson liver retractor

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The study was approved by the local Research Ethics Committee (Approval No. 68185).

Informed consent to participate was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no conflict of interest.

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Authors' contributions

S.C. conceptualized and designed the study, and performed the surgical procedures. S.C. and K.D. wrote the main manuscript text. K.D. performed the statistical analysis. S.C., R.P., and P.T. conducted the blinded intraoperative video reviews and participated in the final consensus scoring. K.L., N.N., E.S., and W.C. were responsible for data acquisition from electronic medical records and the preparation of the blinded video clips. All authors reviewed the manuscript.

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Not applicable.

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Figures

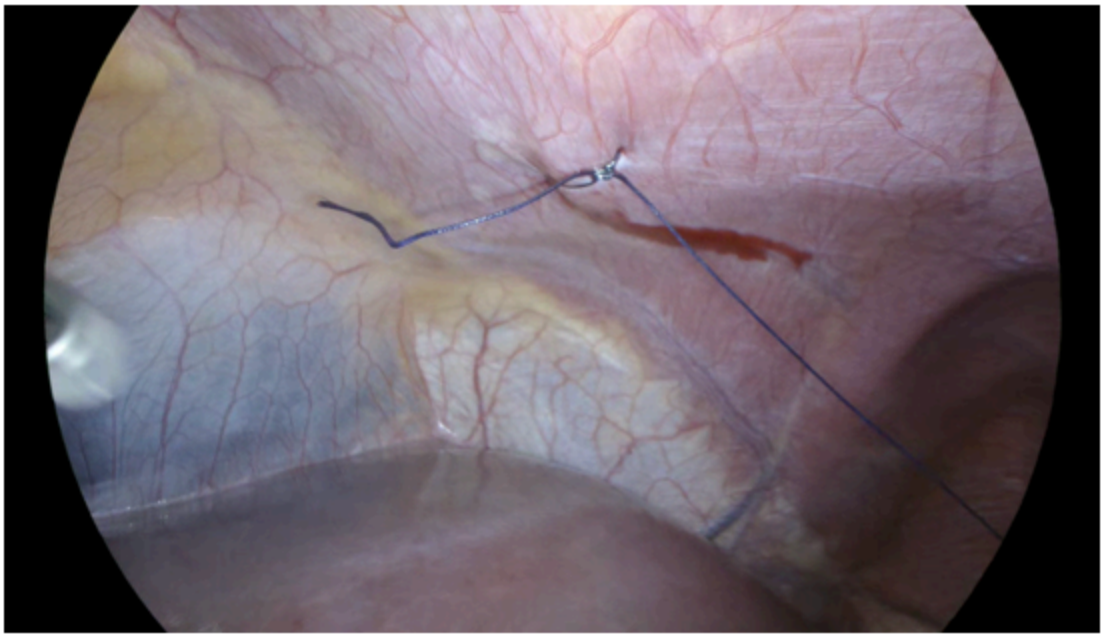


Figure 1

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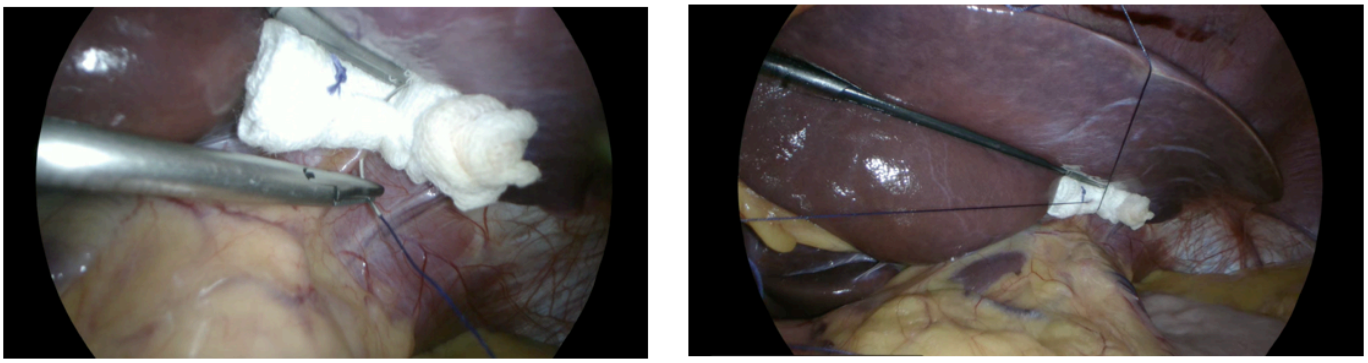


Figure 2

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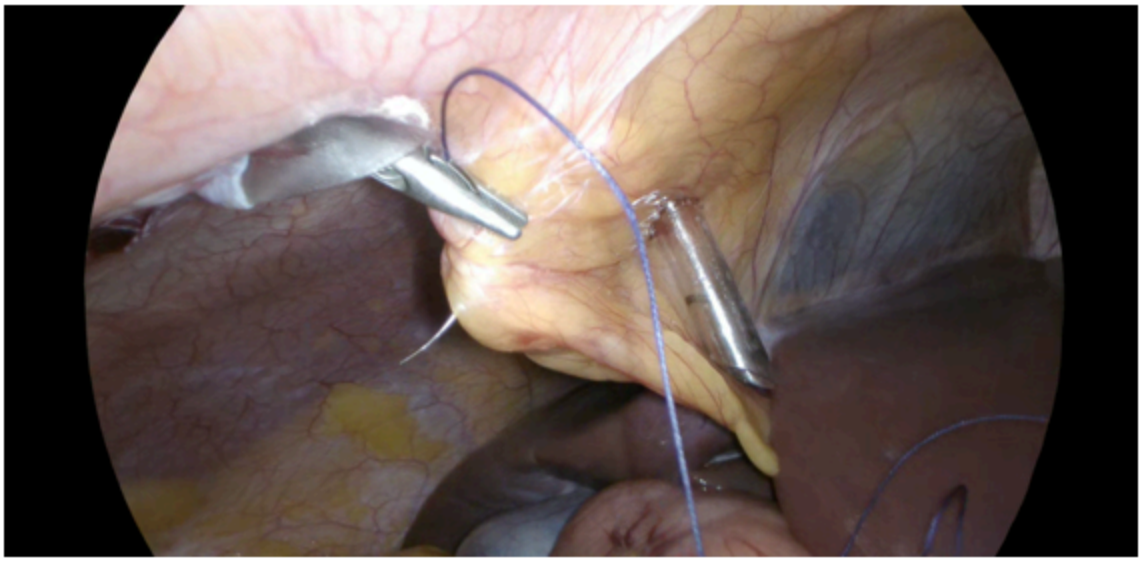


Figure 3

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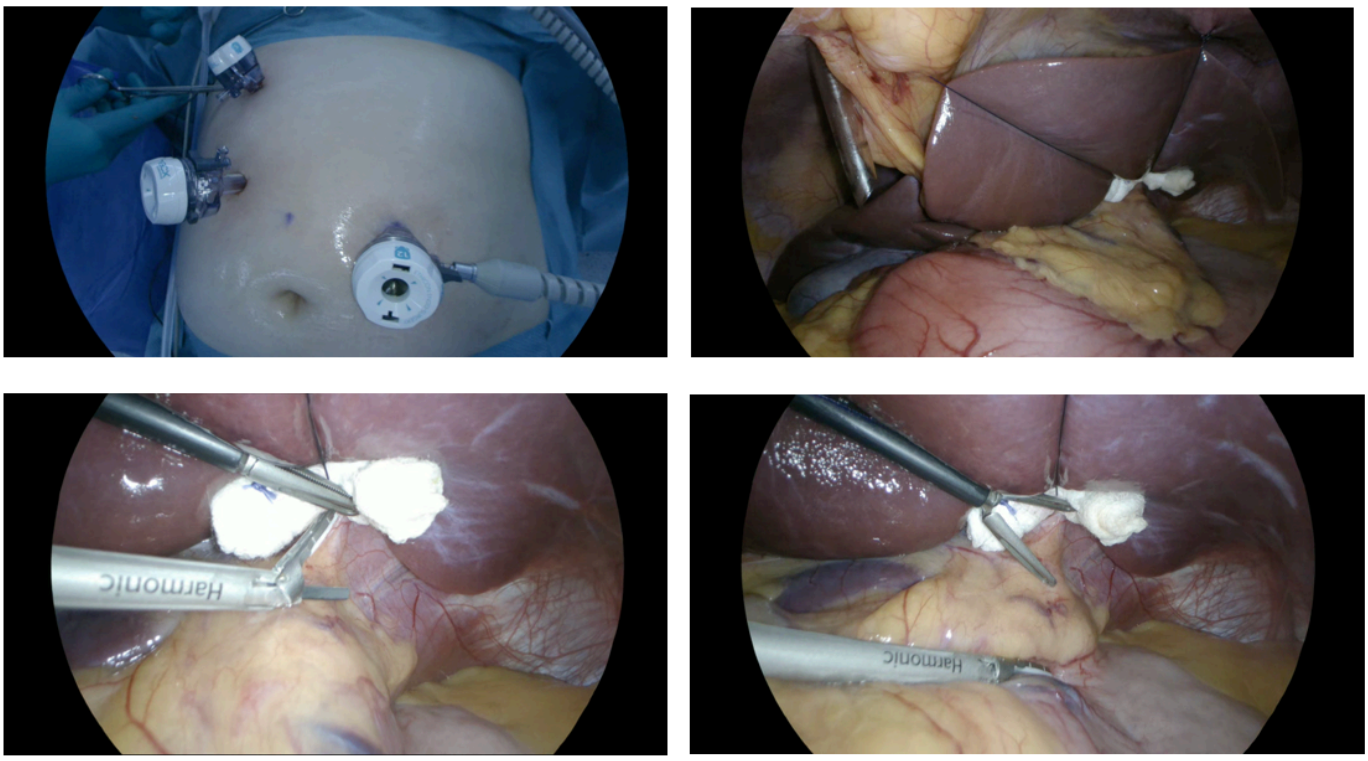


Figure 4

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